

Consumer Demand and Cost Factors Shape the Global Trade Network in Commodity and Manufactured Foods

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Multiple forces operate throughout the global economy and influence the direction, composition, and volume of agri-food trade. The fundamental determinants that impede and foster bilateral trade in two food types, namely staple commodities and manufactured products, are identified using generalized gravity equations. Empirical evidence verified the importance of relative resource endowments and similarities in the structure of partner demand. Other socio-geo-political factors were also found to influence food trade, including the ability of governments to control corruption and curtail disequilibrium in financial markets.

L'économie mondiale est soumise à des forces multiples qui influencent l'orientation, la composition et le volume du commerce agroalimentaire. Les principaux facteurs qui entravent et favorisent le commerce bilatéral de deux types d'aliments, à savoir les matières de base et les produits manufacturés, ont été déterminés à l'aide d'équations de gravité généralisées. L'évidence empirique a vérifié l'importance des dotations relatives en ressources et des similarités dans la structure de la demande d'un partenaire commercial. D'autres facteurs sociaux et géopolitiques, y compris la capacité des gouvernements à combattre la corruption et à réduire le déséquilibre sur les marchés des capitaux, influenceraient aussi le commerce alimentaire.

INTRODUCTION

The global network of trade reveals that patterns vary by product type. Natural resource-based industries have trade patterns distinct from manufacturing industries that source inputs globally. Export and import flows are consistent with what traditional theory suggests for some product types, with trade between distant countries arising primarily from differences in relative factor abundance. For other product types, trade is highly regionalized, regardless of similarities or dissimilarities in factors endowments between trading partners.

Examine, for example, trade patterns characterizing North America's trade in total merchandise and manufactured food where intra-NAFTA export and import shares are comparatively high, given that the non-North-American market constitutes only 30%

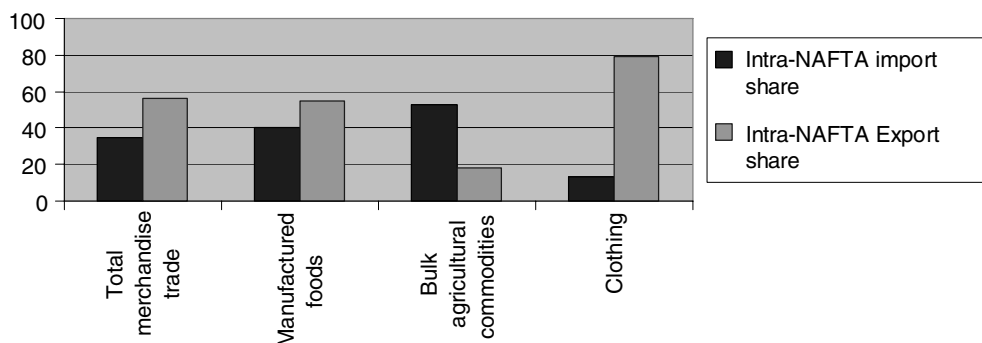


Figure 1. Intra-partner trade shares for North America by sector

of world GDP (Figure 1). More than half (55%) of NAFTA-member merchandise and manufactured food exports are shipped to their NAFTA neighbors, as is 35% of their merchandise imports and 40% of their manufactured food imports. Intra-NAFTA trade is high relative to NAFTA-member foreign trade with the rest of the world, in part, because of interest in minimizing cross-border transaction costs.

Bulk agricultural commodities, clothing, and other goods whose location of production depend upon the global distribution of relatively fixed resources, such as land and labor, are typically traded widely throughout the world. Comparative advantage helps explain why there is a large difference in the intra-NAFTA-export-share to intra-NAFTA-import-share ratios between these two sectors.¹ North America has a competitive edge vis-à-vis most of the rest of the world in grains, oilseeds, livestock products, and other raw agricultural products due to its relative abundance of land. As a major world supplier of primary farm commodities, the share of the three NAFTA countries' exports of bulk agricultural commodities shipped to countries outside of North America is understandably high (82%). In contrast to primary agriculture, North America has a comparative disadvantage in clothing due to its relative high-wage labor force. Not surprisingly, the share of North America's imports of clothing from the rest of the world is comparatively large (87%).

This study examines fundamental forces underlying export supply and import demand of two types of food: (1) processed, manufactured products where transaction costs are thought to be particularly important and (2) staple commodities where factor costs are believed to loom large. An econometric framework is used to sort through the myriad of supply and demand influences that motivate product specialization and the distribution of trade among nations in these two food types. Factors found to underlie the network of bilateral food trade include relative resource endowments, differential tastes and preferences, partner market size, geographical proximity, trade policies, equilibrium in financial markets, cultural linkages, and differences in the level of development.

THE GRAVITY FORMULATION AS APPLIED TO INTERNATIONAL ECONOMICS

In 1687, Newton devised the "Law of Universal Gravitation." This law says that the force of attraction between two objects is directly related to the product of the masses of the objects and indirectly related to the distance separating them. Tinbergen (1962)

posited that the same basic functional form could be applied to international trade flows. Linnemann (1966) provided an economic foundation for the basic gravity model, showing that it is a reduced form from a partial equilibrium model of export supply and import demand.

The general form of the gravity model, as applied to international economics, is as follows:

$$V_{ij} = f(Y_i, Y_j, R_{ij}) \quad (1)$$

where V_{ij} is the value of trade between countries i and j , Y_i is the exporter's size denoting its capacity to supply goods to the world market, Y_j is the importer's size denoting its ability to demand goods from the world market, and R_{ij} measures other factors that affect bilateral trade, including impediments (such as transportation costs) as well as inducements (such as geographic contiguity).

A basic gravity equation found in the literature is

$$X_{ij} = C \frac{Y_i Y_j}{D_{ij}} \quad (2)$$

where X_{ij} is the value of exports from country i to country j , Y_i and Y_j refer to national income, D_{ij} is a measure of distance between the two trading partners, and C is a constant of proportionality. Applied researchers often augment the basic model to include an array of variables to account for additional determinants affecting partner trade, such as the presence or absence of preferential trade agreements. The augmented gravity equation takes the following form

$$x_{ij} = \alpha_1 y_i + \alpha_2 y_j + \sum_{m=1}^M \beta_m \ln(Z_{ij}^m) + \varepsilon_{ij} \quad (3)$$

where x_{ij} is the log of exports from i to j , y_i and y_j are the log of GDP of the exporter and importer, Z_{ij}^m is a set of other observable factors m ($m = 1, \dots, M$) impeding or inducing bilateral trade, and ε_{ij} is the disturbance term.

A few economists have recognized that parameters generated by gravity equations are affected not only by country characteristics, such as market size and trade barriers, but also by the *types* of goods being traded. Rauch (1999) distinguished three kinds of goods, namely (1) *homogenous commodities* whose prices are found on commodity exchanges, (2) *in-between goods* whose reference prices can be found in industry publications, and (3) *other differentiated products*. Similarly, Evenett and Keller (2002) distinguished different types of goods by relying upon the Grubel-Lloyd measure of intra-industry to segment the data into economically meaningful groupings to determine whether the increasing-returns-to-scale or the Heckscher-Ohlin theories best explained bilateral trade.

Despite widespread enrichment attempts, gravity equations were considered to be the "ugly duckling of international economics" for many years. Critics viewed Linnemann's (1966) framework, for example, as being "loose," because it did not include a role for prices (Leamer and Stern 1970; Bergstrand 1985).

Developments in the recent literature have addressed the "looseness" critique by casting the gravity equation within a general equilibrium framework of world trade. For details about the various theoretical models supporting the gravity equation, the interested reader is referred to Anderson (1979), Bergstrand (1985, 1989), Harrigan (1994),

Deardorff (1998), Baier and Bergstrand (2001), Feenstra et al (2001), Eaton and Kortum (2002), Anderson and van Wincoop (2003), and Haveman and Hummels (2004).

We adopt the generalized gravity framework of Anderson and van Wincoop (AvW) (2003) which contains two composite, multilateral price terms. This framework, which is consistent with economic theory, incorporates the Armington assumption that goods produced by different countries are inherently imperfect substitutes by virtue of their provenance. It also assumes complete specialization and identical constant-elasticity-of-substitution preferences.

The gravity equation that emerges from AvW can be expressed as follows:

$$x_{ij} = y_i + y_j + \sum_{m=1}^M \lambda_m \ln(Z_{ij}^m) - (1 - \sigma) \ln(P_i) - (1 - \sigma) \ln(P_j) + \varepsilon_{ij} \quad (4)$$

where P_i is the multilateral outward price variable that depends on all bilateral resistances for origin i ; P_j is the corresponding multilateral inward price variable for destination j ; and σ is the elasticity of substitution between the countries' goods. The main insight from Eq. (4) is that partner trade depends not on just the overall bilateral trade barrier, but also on multilateral resistances.

MODEL SPECIFICATION FOR FOOD

The scope of the empirical analysis in this study is limited to trade in agri-food products.² We account for different types of foods traded by making a distinction between staple commodities and processed products and estimate separate gravity equations for each food type in 1996, 1998, 2000, and 2002.³ We impose the small-market assumption which circumvents the issue of endogeneity.⁴ This assumption seems reasonable because trade from i to j is small relative to i 's trade flows to all other markets.

Model specification, with country-fixed effects suppressed for notational simplicity, is as follows:

$$\begin{aligned} \ln(X_{ijs}) = & \beta_{1s} \ln(Y_i) + \beta_{2s} \ln(Y_j) + \beta_{3s} \ln(D_{ij}) + \beta_{4s} \ln(DY_{ij}) + \beta_{5s} \ln(DT_{ij}) \\ & + \beta_{6s} \ln(QG_j) + \beta_{7s} \ln(EM_{ij}) + \beta_{8s} (CB_{ij}) + \beta_{9s} (LS_{ij}) \\ & + \beta_{10s} (CH_{ij}) + \beta_{11s}^k (PTA_{ij}^k) + \varepsilon_{ij} \end{aligned} \quad (5)$$

where subscript s refers either to commodity or manufactured foods, i to the exporting country, and j to the importing country. X_{ijs} is the value of the bilateral trade flow between i and j for s .⁵ Y_i is exporter's GDP, denoting the size of the supplying market. Y_j is importer's GDP, signifying the size of the demanding market. D_{ij} measures the distance between the two trading partners, a proxy for transportation costs. DY_{ij} is the absolute difference in per-capita income between trading partners. DT_{ij} quantifies exporter-to-importer land/labor ratios. QG_j measures the quality of governance in the importing country.⁶ EM_{ij} measures exchange-rate misalignment. Other observable determinants impeding or inducing bilateral trade include (1) common borders (CB_{ij}), a dummy variable which equals 1 when i and j share a common border and 0 otherwise; (2) language similarity (LS_{ij}), a dummy variable which equals 1 whenever a language is spoken by at least 9% in both countries and 0 otherwise⁷; (3) colonial heritage (CH_{ij}), a

dummy variable which equals 1 if two countries have established colonial ties since 1945 and 0 otherwise; and (4) preferential trade agreements (PTA_{ij}^k), dummy variables which equal 1 when partners are members of regional trade agreements k (i.e., NAFTA, EU, and MERCOSUR) and 0 otherwise.

The incorporation of country-fixed effects within Eq. (5) strengthens economic and statistical interpretation. The use of fixed effects provides a relatively easy way to control for exporter (outward) and importer (inward) multilateral prices, terms that Anderson and van Wincoop (2003) have shown to be central to correct specification of gravity models.⁸ Moreover, they have the advantage of minimizing coefficient bias attributable to omitted variables (Mátyás 1997). Omitted variable bias is a problem whenever there are strong correlations between observable variables in the empirical model (i.e., income, distance) and nonobservable trade determinants (i.e., domestic tax codes, anti-trust rules, and product standards).

The DY_{ij} variable is designed to capture the Linder effect. Linder (1961) observed that suppliers of differentiated products produce primarily to satisfy the tastes of domestic consumers. This practice leads to trade with countries whose consumers have similar tastes. The null hypothesis typically used to empirically test whether tastes and preferences affect the distribution of trade is that bilateral trade is a negative function of the absolute difference in per capita incomes in the two regions (Thursby and Thursby 1987; Bergstrand 1990).

A consensus has emerged among academics and policymakers that good governance is critical to economic development (North 1990). This consensus leads us to hypothesize that the quality of governmental institutions in the importing countries (QG_j) affects the willingness and ability of entrepreneurs to trade in specific markets. To examine the relationship between governance and food trade, we make use of the control-of-corruption indicator developed at the World Bank (Kaufmann et al 2005). This indicator is based upon factual information about governmental institutions as well as subjective responses to survey questions designed to capture the environment in which regulations are applied.

Finally, we use a measure of exchange-rate misalignment (EM_{ij}) to determine how financial linkages among countries affect food trade. According to economic theory, domestic prices of foreign currencies are neutral. Consequently, exchange rates are not expected to influence domestic or foreign decisions affecting supply and demand. Policy-makers express concern from time-to-time about over- and under-valued exchange rates. Witness, for example, the current public debate about the appropriate foreign-currency value of the Chinese renminbi. Moreover, the economic literature is replete with empirical evidence showing that market-determined exchange rates are often out of equilibrium. Dornbusch (1976) and Bergsten and Williamson (2003) show that prolonged departures of actual exchange rates from purchasing power parity are not uncommon phenomena, even for the developed countries having flexible exchange rates.

To test whether EM_{ij} adversely affects food trade, we modify Perée and Steinherr's (1989) indicator of "exchange-rate uncertainty" (EU_{ij}), with both measures capturing current as well as accumulated experience⁹:

$$EU_{ij} = V_t^1 + V_t^2 = \left[\frac{\max Z_{ij,t-k}^t - \min Z_{ij,t-k}^t}{\min Z_{ij,t-k}^t} \right] + \left[1 + \frac{|Z_{ij,t} - Z_{ij}^p|}{Z_{ij}^p} \right]^2 \quad (6)$$

where $\max(\min)Z_{ij,t-k}$ is the maximum (minimum) value of the absolute value of the exchange rate index over time interval of size k past period. The central notion underlying V_t^1 is that traders' uncertainty is conditioned by their memory of the high and low exchange rates over some relevant period, which we chose to be 10 years (the range that both Cho et al (2002) and Perée and Steinherr (1989) also selected). V_t^2 adds more recent information. It puts the contemporaneous exchange rate into historical perspective.

EM_{ij} differs from EU_{ij} in that the former is calculated using real (2000) exchange rates, while the latter is derived from nominal rates. We follow the practice adopted by Rosenberg (2003) and take the mean of real exchange rates over a 30-year period (1974–2003) as the measure of the purchasing-power equilibrium rate (Z_{ij}^p). The result is that EM_{ij} quantifies the notion of exchange-rate misalignment.

DATA

We have assembled a cross-sectional data set for 69 countries for 1996, 1998, 2000, and 2002.¹⁰ This data set includes all countries for which we could obtain reliable macroeconomic data on exchange rates and years for which both governance indicators and information about bilateral trade flows were available. The 69 countries accounted for 82% of the world's cross-border trade in food and 95% of global GDP in 2002.

Data sources:

- The data on food trade were derived from *UN Comtrade* (United Nations, UN Statistical Office 2005).
- Distance between capital cities and/or major commercial centers were calculated using the great circle method obtained from the U.S. Department of Agriculture, Agricultural Research Service (2005).
- The data on bilateral exchange rates, derived from information secured from International Financial Statistics of the International Monetary Fund and Financial Statistics of the Federal Reserve Board, came from the U.S. Department of Agriculture, Economic Research Service (2005).
- Information about arable land came from *FAOSTAT* (United Nations, Food and Agricultural Organization 2005).
- Governance indicators came from World Bank's *Governance Indicators* (World Bank 2005a).
- Data about colonial heritage and language similarity were obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (2005) website.
- All other data came from the *World Development Indicators* (World Bank 2005b).

EMPIRICAL FINDINGS

The econometric model, which controls for partner size, provides evidence that the distribution of natural resources is an economic driver underlying trade in food. Relative factor endowments—quantified as partner arable-land-to-total-labor ratios—positively affect trade in both commodity and manufactured foods. The food trade elasticities with respect to differences in natural resources ranged from 0.08 to 0.11 (Tables 1 and 2). The empirical findings for DT_{ij} show that factor proportions are an important determinant of food trade in both staple commodities and processed products.

Table 1. Generalized gravity equation coefficients for land-based food trade

Variables	Symbols	1996	1998	2000	2002
Exporter's income	Y_i	1.67*** (0.07)	1.57*** (0.07)	1.62*** (0.08)	1.63*** (0.11)
Importer's income	Y_j	0.89*** (0.02)	0.85*** (0.02)	0.82*** (0.02)	0.85*** (0.02)
Distance	D_{ij}	-1.15*** (0.04)	-1.09*** (0.04)	-1.19*** (0.04)	-1.21*** (0.04)
Income differences	DY_{ij}	0.08*** (0.02)	0.05* (0.03)	0.05** (0.02)	0.02 (0.02)
Land/labor differences	DT_{ij}	0.09*** (0.02)	0.11*** (0.02)	0.08*** (0.02)	0.10*** (0.02)
Government control of corruption	QG_j	0.28** (0.13)	0.49*** (0.13)	0.65*** (0.13)	0.28** (0.11)
Exchange-rate misalignment	EM_{ij}	-0.41*** (0.11)	0.04 (0.12)	0.12 (0.10)	-0.33*** (0.11)
Language similarity	LS_{ij}	0.46*** (0.08)	0.44*** (0.08)	0.50*** (0.08)	0.57*** (0.08)
Colonial heritage	CH_{ij}	1.32*** (0.17)	1.22*** (0.20)	1.30*** (0.17)	1.19*** (0.20)
Common border	CB_{ij}	0.40** (0.19)	0.51*** (0.18)	0.33* (0.17)	0.32* (0.17)
NAFTA	$NAFTA_{ij}$	-0.05 (0.53)	-0.06 (0.45)	0.13 (0.50)	0.08 (0.48)
EU	EU_{ij}	0.11 (0.12)	0.35*** (0.12)	0.18* (0.11)	0.20* (0.12)
MERCOSUR	$MERCOSUR_{ij}$	0.99*** (0.34)	0.91** (0.39)	1.10** (0.46)	0.55 (0.58)
Adjusted R^2		0.67	0.67	0.68	0.69
Root mean square error		1.75	1.74	1.70	1.69
Number of observations		3719	3622	3815	3747

Parentheses denote White's standard errors which are consistent and robust to heteroskedasticity. Superscripts ***, **, and * denote that the null hypothesis is rejected at the 0.01, 0.05, and 0.10 significance levels, respectively.

Absolute differences in per-capita income negatively affect trade in manufactured foods, confirming Linder's (1961) hypothesis that two countries with similar per-capita income trade disproportionately with each other because of comparable tastes and preferences.¹¹ The finding that the elasticity of DY_{ij} with respect to exports of manufactured foods was -0.12, on average, provides empirical confirmation that consumers have non-homothetic preferences for processed foods, goods that are typically differentiated. In other words, consumers with similar per-capita income purchase processed foods in similar proportions because they want the same things. The Linder phenomenon, combined with the value that high-income consumers place on product variety, motivate trade in manufactured foods between developed countries.

Table 2. Generalized gravity equation coefficients for processed food trade

Variables	Symbols	1996	1998	2000	2002
Exporter's income	Y_i	1.38*** (0.07)	1.32*** (0.07)	1.46*** (0.11)	1.42*** (0.12)
Importer's income	Y_j	0.65*** (0.02)	0.64*** (0.02)	0.60*** (0.02)	0.64*** (0.02)
Distance	D_{ij}	-1.11*** (0.05)	-1.14*** (0.05)	-1.22*** (0.05)	-1.31*** (0.05)
Income differences	DY_{ij}	-0.08*** (0.03)	-0.13*** (0.03)	-0.11*** (0.02)	-0.15*** (0.03)
Land/labor differences	DT_{ij}	0.11*** (0.02)	0.08*** (0.02)	0.11*** (0.02)	0.11*** (0.02)
Government control of corruption	QG_j	0.24* (0.13)	0.53*** (0.13)	0.70*** (0.13)	0.49*** (0.12)
Exchange-rate misalignment	EM_{ij}	-0.72*** (0.10)	-0.15 (0.11)	0.05 (0.11)	-0.03 (0.11)
Language similarity	LS_{ij}	0.90*** (0.09)	0.95*** (0.09)	1.11*** (0.08)	1.08*** (0.08)
Colonial heritage	CH_{ij}	0.86*** (0.17)	0.91*** (0.18)	0.75*** (0.18)	0.87*** (0.20)
Common border	CB_{ij}	0.45** (0.22)	0.50** (0.20)	0.29 (0.20)	0.35* (0.21)
NAFTA	$NAFTA_{ij}$	1.07*** (0.32)	1.10*** (0.30)	1.26*** (0.33)	1.26*** (0.37)
EU	EU_{ij}	-0.15 (0.13)	-0.16 (0.12)	-0.02 (0.12)	-0.34*** (0.13)
MERCOSUR	$MERCOSUR_{ij}$	1.22** (0.63)	1.62*** (0.50)	1.44** (0.58)	1.45*** (0.41)
Adjusted R^2		0.69	0.69	0.70	0.70
Root mean square error		1.61	1.61	1.61	1.62
Number of observations		2907	2908	3104	3113

Parentheses denote White's standard errors which are consistent and robust to heteroskedasticity. Superscripts ***, **, and * denote that the null hypothesis is rejected at the 0.01, 0.05, and 0.10 significance levels, respectively.

Trade in primary food commodities was not expected to be affected by differential tastes and preferences to the same degree as manufactured foods because the former, unlike the latter, are relatively nondifferentiable. In fact, the DY_{ij} elasticities with respect to commodity foods were found not to be negative. This finding supports the hypothesis that similarities in individual wealth do not, in contrast to processed foods, induce greater trade in food staples.

Interestingly, the empirical estimations yielded positive, not negative, DY_{ij} elasticities for commodity foods, elasticities that ranged from 0.05 to 0.08 between 1996 and 2000. The generation of nonnegative coefficients shows that the wider the level-of-development gap between two trading partners, the greater is their trade in commodity foods. Indeed, observable trade patterns are consistent with this finding. They show that many developing

countries have become reliant upon foreign sources of relatively low-priced commodity imports to help meet domestic demand for food staples. They also show that developed countries (i.e., Australia, Canada, and the United States) supply low-income countries with the majority of their food-commodity imports.

We offer two possible supply oriented explanations for the positive DY_{ij} elasticities for commodity foods. (1) Capital-intensive, large-scale operations often found on farms in the high- but not low-income countries, generate scale economies that provide a competitive edge to developed-country producers of food staples. (2) Government policies which subsidize farmers in the developed, but not in the developing countries, may also provide a competitive advantage to primary agricultural production in the high-income countries.¹²

The other trade drivers specified in the model affect both food sectors in not unexpected ways. Geographic contiguity, language similarity, colonial linkages, and government control of corruption augmented bilateral food trade from i to j during the four time periods were analyzed. Distance and exchange-rate misalignment negatively affected food trade. The presence of preferential trading agreements either increased partner trade or had no discernable impact.

Geography matters a great deal. Contiguity was found to be beneficial to cross-border food trade, while distance was ascertained to be negatively related to food trade. Common borders increased food trade 1.4-to 1.7-fold (except for manufactured foods in 2000 when adjacency had no discernable impact on trade). Distance, a proxy for transportation costs, had a slightly greater impact on manufactured food trade than on trade in commodity foods. The average distance elasticity with respect to product-food trade was -1.20 , in contrast to -1.16 for commodity foods. The distance coefficient became increasingly negative over time, suggesting that costs for handling and transit may have increased, despite advances in technology.

The empirical results confirm expectations that the domestic institutional environment is an important factor driving trade. The control-of-corruption elasticities for commodity and manufactured foods are 0.5 and 0.4, respectively. Clearly, the ability of governments to control fraud and bribery provides entrepreneurs with confidence to engage in commercial activity. The result is more trade in food.

The empirical results also support the Cho et al (2002) finding that exchange-rate misalignment adversely affects agricultural trade.¹³ Disequilibrium in exporter-importer financial markets—as measured by departures of real contemporaneous exchange rates from equilibrium levels and extremes values in the recent past—affects food trade negatively. EM_{ij} parameters were statistically significant in 1996 when the U.S. dollar was undervalued and in 2002 when the U.S. dollar was overvalued.¹⁴ Interestingly, the EM_{ij} elasticities were not significantly different than zero in 1998 and 2000, a finding that corresponds with equilibrium in financial markets near and at the turn of the century.

Cultural linkages also matter, witness the positive and highly significant language-similarity and colonial heritage parameter estimates. The ability of entrepreneurs to communicate in the same language was found to triple trade in manufactured foods and increase trade in food commodities 1.5-fold, on average. The empirical results also show that countries having a common colonial heritage more than doubled bilateral trade in commodity foods and increased partner trade in manufactured food products 1.5-fold.

Preferential trading agreements often matter as well. The empirical results show that NAFTA, MERCOSUR, and the EU increased food trade among member countries beyond what would have occurred in their absence. The EU enlarged intra-EU trade in commodity foods between 1998 and 2002. It did not, however, increase trade among member countries in manufactured foods. NAFTA, by contrast, had a positive impact on trade in manufactured foods, increasing partner trade more than threefold between 1996 and 2002. Moreover, NAFTA did not have any discernable impact on stimulating trade in food commodities.

MERCOSUR had the greatest impact of the three trade agreements increasing partner trade. Membership in MERCOSUR amplified partner trade in manufactured foods fourfold between 1996 and 2002; and it increased partner trade in commodity foods threefold between 1996 and 2000. However, MERCOSUR had no effect on partner trade in commodity foods in 2002; and its impact on member-to-member trade in manufactured foods declined from its fivefold peak after 1998. The diminishing impact of MERCOSUR is likely due to domestic macroeconomic shocks that induced national retrenchment.

Preferential-trade-agreement findings show that NAFTA and MERCOSUR induced greater trade among member countries in manufactured foods than in commodity foods. This is partially explained by higher tariff and nontariff barriers for differentiated food products than for the staple commodities. The more open, post-agreement markets within NAFTA and MERCOSUR likely rationalized domestic manufactured production, fostered niche-area specialization, and stimulated intra-regional trade. The fact that the presence of the EU did not have a significant impact increasing intra-EU trade in manufactured food may be due to the fact that the EU has been in existence for a much longer period of time than either NAFTA or MERCOSUR. The EU's internal trade-enhancing impact is likely to have occurred in the early years.

CONCLUSIONS

This study provides quantitative information concerning fundamental drivers underlying contemporary food trade, advancing understanding about the global export-import network. A gravity-based econometric framework is used to identify the relevance of various demand and supply forces that economic theory identifies as being important to bilateral trade of two types of food: (1) processed, manufactured products and (2) staple commodities. The framework is also used to quantify the role that other geo-socio-political factors exert on this trade.

The empirical analysis shows that demand-oriented trade theory is relevant to international trade in manufactured foods, but not to trade in commodity foods. Absolute differences in per-capita incomes were found to negatively affect trade in the former, but not in the latter. This finding has several implications. One, it provides empirical support for Linder's hypothesis, namely that countries with similar wealth trade disproportionately with each other in processed food. Two, it suggests that competitive pricing, as opposed to comparable tastes and preferences, provides the primary motivation for trade in commodity foods, goods that are relatively homogenous and do not possess highly differentiated product characteristics. Three, this finding provides an explanation for both the high degree of intra-industry trade observed for manufactured foods in general and the concentration of manufactured food trade among the developed countries,

characteristics not shared with trade in commodity foods where specialization and one-way trade are widespread.

The applied analysis also lends support to supply-oriented explanations of cross-border food trade. For example, the empirical results show that the higher the land/labor ratio country i possesses in comparison with partner j , the greater its exports of food to j are likely to be in both commodity and manufactured food. This finding shows that relative factor endowments is an important driver of bilateral trade, just as Heckscher-Ohlin theory leads us to believe.

Quantitative evidence shows that economic geography and cultural linkages matter a great deal for trade in both commodity and manufactured food. Clearly, common national borders, language similarity, colonial heritage, and distance between trading partners help explain global food trade patterns. The empirical results also show that NAFTA, MERCOSUR, and the EU increased food trade among member countries beyond what would have occurred in their absence. MERCOSUR had the greatest impact of the three preferential trade agreements increasing partner trade during 1996–2002.

Lastly, model results show that the institutional environment is important. The failure of governments to control corruption in destination markets adversely affects food trade as does the inability of monetary authorities to curb disequilibrium in exchange-rate markets.

The future agenda for applied research focused on what motivates food trade is a challenging one. Much more work can be done to further clarify the nature of transaction costs affecting the bilateral network of this trade. Particularly promising areas include efforts to gain a better understanding of the role of transportation logistics and agricultural tariffs.¹⁵

Clearly, globalization and the relentless pressure to reduce costs and increase export sales have placed a premium on coordination of logistics and efficient supply-chain management. National inefficiencies in customs clearances, restrictive protocols on the movement and securitization of cargo, poor quality inland road and rail systems, and unnecessary delays at terminals inhibit trade. Underscoring the importance of just one aspect of domestic logistics, Clark et al (2004) found port inefficiency to be a considerably greater barrier to trade than tariffs for countries exporting goods to the United States.

Agricultural tariffs are, on average, considerably higher than levies imposed on most other products (US Department of Agriculture, Economic 2001). In fact, the high degree of tariff protection in agriculture helps explain why estimates gauging the impact of full liberalization in the Doha Round show that the greatest gain comes from market reforms in world agriculture (Anderson et al 2006; Organization for Economic Co-operation and Development 2006). This finding from computable-general-equilibrium models underscores Research Service the value of enriching the trade-policy component in econometric gravity analyses beyond that provided by preferential trade agreements.

NOTES

¹Low intra-NAFTA export shares denote North American competitiveness with the rest of the world. Conversely, high intra-NAFTA import shares reflect rest-of-world competitiveness with North America.

²One reviewer raised a controversial issue about the appropriateness of using the gravity framework, which is grounded in general equilibrium theory, for empirical analyses of sectors, such as food,

which comprise a small fraction of total trade. We contend that virtually all applied work involves partial equilibrium analysis to one degree or another due to data limitations. Most studies found in the literature that employ the gravity model focus on merchandise trade. Merchandise trade does not, however, include all trade in the real goods economy. It excludes trade in services, a very large sector in the global economy. Applied studies often do not include developing countries due to the absence of data. Some analysts have restricted attention to just two or three countries. A notable example is the path-breaking, gravity-based research by McCallum (1995) in which attention was focused on trade among provinces and states within and between Canada and the United States. A number of empirical studies using the gravity framework have targeted agriculture. Zahniser et al (2002) examined total agriculture. Prentice et al (1998) limited attention to the pork subsector. Furtan and van Melle (2004) focused on grains; meat, fish and dairy; fruits and vegetables; and other agriculture. We believe that the gravity framework provides a useful vehicle to gain understanding why food trade occurs across national boundaries.

³Both trade and income terms need to be converted into real terms when using panel data and pooled gravity analysis. To avoid price index problems (a.k.a. the use of inappropriate deflators), we elected to focus on cross-sectional analysis. Indeed, most gravity estimations found in the literature are cross-sectional.

⁴Seemingly unrelated regression (SUR) is the appropriate estimator, given the small-market assumption. However, we employ ordinary least squares (OLS) since our model uses identical regressors in both the commodity and manufactured food equations. SUR parameter estimates are equivalent to those generated by OLS in our model specification.

⁵We follow common practice and drop observations when i does not trade with j . This convention, which may lead to biased coefficients, circumvents the problem that the log of zero is not defined. In future analysis, we intend to employ a balanced trade matrix, one which will include zero trade observations.

⁶The governance variable for exporters (QG_i) was removed from our fixed-effects model to mitigate the effects of multicollinearity. We chose to exclude QG_i rather than QG_j because the latter had a more pronounced positive impact on food trade than did the former in standard-gravity model estimations.

⁷Language similarity is defined in terms of a threshold of the populations in each partner country that possess a common language. The 9% threshold serves to denote the level at which the ability to communicate is viewed as not imposing burdensome transaction costs.

⁸Rose and van Wincoop (2001), Anderson and van Wincoop (2004), and Feenstra (2004) observe that it is more difficult to render empirical content to Anderson and van Wincoop's non-linear structural model than to use the country-fixed-effects approach and OLS.

⁹The Perée and Steinherr's (1989) index is not a forward-looking measure of uncertainty, expressed in terms of deviations of actual from expected exchange rates. Rather it is a backward-looking indicator that can perhaps be best described as approximating exchange-rate misalignment.

¹⁰The 69 countries include Algeria, Australia, Austria, Bangladesh, Belgium-Luxembourg, Brazil, Cameroon, Canada, Chile, China (mainland), Colombia, Costa Rica, Denmark, Dominican Republic, Egypt, El Salvador, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Kuwait, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Paraguay, Philippines, Poland, Portugal, Saudi Arabia, Senegal, Singapore, South African Customs Union (Botswana, Lesotho, Namibia, South Africa, and Swaziland), South Korea, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Trinidad-Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela, Zambia, and Zimbabwe.

¹¹Thursby and Thursby (1987) also found quantitative evidence supporting Linder's hypothesis.

¹²An anonymous reviewer provided this policy explanation.

¹³Using a gravity model, Cho et al (2002) found evidence that agricultural trade is particularly susceptible to exchange-rate volatility and exchange-rate misalignment and that the negative effects on the growth of agricultural trade is more pronounced than for total merchandise trade.

¹⁴In response to a reviewer's suggestion, we report standard errors instead of *t*-statistics in Tables 1 and 2. This suggestion is due to concern about the distribution of the parameter estimates based on the common practice of pre-testing when estimating large gravity models. Any mention of significance in the text is based upon an assumed *t*-distribution.

¹⁵At the Economic Research Service, we are currently working on developing a comprehensive database on agricultural tariffs which, once completed, will enable us to better examine the impact of protection on bilateral food trade.

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